Fiscal Year:	FY 2020	**Task Last Updated:**	FY 04/22/2020
PI Name:	Seidler, Rachael D. Ph.D.		
Project Title:	Bed Rest Combined with 0.5% CO2 as a Spaceflight Analog to Study Neurocognitive Changes: Extent, Longevity, and Neural Bases		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **Sensorimotor**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	rachaelseidler@ufl.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	352-294-1722
Organization Name:	University of Florida		
PI Address 1:	Applied Physiology & Kinesiology		
PI Address 2:	FLG 142, P.O. Box 118205		
PI Web Page:			
City:	Gainesville	**State:**	FL
Zip Code:	32611-8205	**Congressional District:**	3
Comments:	NOTE: PI moved to University of Florida in July 2017; previous affiliation was University of Michigan.		
Project Type:	Ground	**Solicitation / Funding Source:**	2014-15 HERO NNJ14ZSA001N-MIXEDTOPICS. Appendix E: Behavioral Health & Human Health Countermeasures Topics
Start Date:	06/29/2017	**End Date:**	01/01/2023
No. of Post Docs:	2	**No. of PhD Degrees:**	
No. of PhD Candidates:	3	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Williams, Thomas	**Contact Phone:**	281-483-8773
Contact Email:	thomas.j.will1@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: Changed end date to 1/01/2023 per JSC-SA Grant Technical Officer (Ed., 2/23/22) NOTE: Changed end date to 1/01/2022 per NSSC information (Ed., 3/12/21) NOTE: Changed end date to 1/01/2021 per L. Juliette/HRP (Ed., 2/19/2020) NOTE: Changed end date to 12/28/2019 per NSSC information (Ed., 10/9/19)		
Key Personnel Changes/Previous PI:	April 2020 report: Dr. Donna Roberts, Medical University of South Carolina, had a project added on to our VaPER study in which she collected MRI perfusion scans on the same subjects at the same time points and is CoInvestigator during this time.		

COI Name (Institution):	Bloomberg, Jacob Ph.D. (NASA Johnson Space Center) Mulavara, Ajitkumar Ph.D. (Universities Space Research Association) Kuehn, Simone Ph.D. (Max Planck Institute for Human Development) Stahn, Alexander Ph.D. (University of Pennsylvania) Roberts, Donna M.D. (Medical University of South Carolina)
Grant/Contract No.:	80NSSC17K0021
Performance Goal No.:	
Performance Goal Text:	
Task Description:	NRA NNJ14ZSA001N-MIXEDTOPICS requests proposals in the area of "Risk Characterization and Monitoring of Behavioral Health and Performance Relevant Outcomes" to determine the effects of 30 days head down tilt bed rest in a 0.5% CO2 environment on neurobehavioral signs and symptoms, neurostructural and neurofunctional alterations, and changes in cognitive function and operational task performance. Our Neuromapping studies measure precisely these metrics in a flight study and a 70 days head down tilt bed rest study under normative conditions. Here, our overarching goal is to quantify neurocognitive changes and associated neural structural and functional alterations occurring as a result of a 30 days head down tilt bed rest plus 0.5% CO2 environment, serving as a spaceflight analog exposure. We will identify the relationship between these neural changes and behavioral function. Our approach utilizes cutting edge neuroimaging techniques and a broad ranging battery of sensory, motor, and cognitive assessments to investigate neuroplastic and maladaptive brain changes occurring in a spaceflight analog environment. Success in this endeavor would 1) result in identification of the underlying neural mechanisms and operational risks of changes in behavior with a spaceflight analog, and 2) identify whether a return to normative behavioral function following bed rest is associated with a restitution of brain structure and function or instead is supported by substitution with compensatory brain processes. Moreover, addition of a CO2 group will enable us to parse out the multiple mechanisms contributing to any spaceflight induced neural structural and behavioral changes that we observe in our ongoing flight projects ((NASA flight project, Seidler Principal Investigator (PI); ILSRA--International Life Sciences Research Announcement flight study, Stahn PI)), and comparison with our recently completed bed rest projects (Seidler and Stahn, PIs) will allow us to delineate brain and behavioral changes occurring with long term exposure to slightly elevated CO2 levels.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project uses long duration head down tilt bed rest as a spaceflight environment analog. The intervention mimics several aspects of human spaceflight, including a shift of fluids towards the head and unloading of the body. Thus the results are relevant for clinical populations on Earth, including individuals who are bed ridden for extended periods of time. Moreover, the shifts that occur in how the brain weights sensory information show some similarities with age changes in sensory processing. Thus understanding how the brain and behavior change in response to this environment can also shed insight into the aging process on Earth.
Task Progress:	We are currently investigating spaceflight effects on brain structure and function in our ongoing NASA funded project NNX11AR02G "Spaceflight Effects on Neurocognitive Performance: Extent, Longevity, and Neural Bases." Under the current project "Bed Rest Combined with 0.5% CO2 as a Spaceflight Analog to Study Neurocognitive Changes: Extent, Longevity, and Neural Bases" (NASA 80NSSC17K0021) we collected data with our battery of structural and functional MR brain imaging, cognitive, and operational task metrics at: envihab in a head down tilt bed rest study with elevated ambient CO2 levels. With the current project, we have been able to determine the neural and neurocognitive effects of unloading, reduced sensory inputs, increased cephalic fluid distribution, and 0.5% CO2. The latter was not achieved in our previous bed rest study, but has critical importance as International Space Station crewmembers have exhibited symptoms of CO2 exposure at smaller CO2 levels than what is typically seen in Earth-based studies (Law et al., 2014). Thus, we are able to 1) identify the underlying neural mechanisms and operational risks of spaceflight-induced changes in behavior using a well-established spaceflight analog, and 2) identify whether a return to normative behavioral function following recovery from prolonged bed rest plus 0.5% CO2 exposure is associated with a restitution of brain structure and function or instead is supported by substitution with compensatory brain processes. Longer duration exposure to elevated CO2 levels results in increased cerebral blood flow and mild performance impairments. It is thus very important to examine interactions of CO2 and head down tilt on brain structure, function, and operational behaviors. Space Station crewmembers have exhibited symptoms of CO2 exposure at lower levels than typically occur on Earth (Law et al., 2014). Moreover, addition of a CO2 group will enable us to parse out the multiple mechanisms contributing to any spaceflight induced neural structural and behavioral changes that we observe in our ongoing flight project. We have addressed this with the following project aims: Aim 1: Identify changes in brain structure, function, and network integrity as a function of 30 days head down tilt bed rest plus 0.5% CO2 and characterize their time course. Aim 2: Specify relationships between structural and functional brain changes and performance and characterize their time course. Aim 3: Identify predictors of individual differences in bed rest plus 0.5% CO2 responses. Data collection for this project was successfully completed at the :enivhab facility in Cologne, Germany, in December 2017 and all data have been transferred. We are finalizing analysis of these data and have already published some manuscripts reporting the results. Interestingly, nearly half of the subjects in this campaign developed signs of Spaceflight Associated Neuro-ocular Syndrome (SANS), which affects approximately half of long duration astronauts. This allowed us the unique opportunity to compare the two subgroups. These analyses comparing SANS and noSANS subjects should be interpreted with caution, however. The overall project enrollment was 11 subjects, which was already below the number for which our experiments were powered. Comparing subgroups with five and six subjects makes generalization of the findings very difficult. Reference: Law J, Van Baalen M, Foy M, Mason SS, Mendez C, Wear ML, Meyers VE, Alexander D. Relationship between carbon dioxide levels and reported headaches on the International Space Station. J Occup Environ Med. 2014 May;56(5):477-83.

Bibliography Type:	Description: (Last Updated: 03/18/2025)
Articles in Peer-reviewed Journals	Hupfeld KE, Lee JK, Gadd NE, Kofman IS, De Dios YE, Bloomberg JJ, Mulavara AP, Seidler RD. "Neural correlates of vestibular processing during a spaceflight analog with elevated carbon dioxide (CO2): A pilot study." Front Syst Neurosci. 2020 Jan 10;13:80. https://doi.org/10.3389/fnsys.2019.00080 ; PubMed PMID: 31998084; PubMed Central PMCID: PMC6965349 , Jan-2020
Articles in Peer-reviewed Journals	Lee JK, De Dios Y, Kofman I, Mulavara AP, Bloomberg JJ, Seidler RD. "Head down tilt bed rest plus elevated CO2 as a spaceflight analog: Effects on cognitive and sensorimotor performance." Front Hum Neurosci. 2019 Oct 17;13:355. eCollection 2019. https://doi.org/10.3389/fnhum.2019.00355 ; PubMed PMID: 31680909; PubMed Central PMCID: PMC6811492 , Oct-2019